give a better infiltration. It is then oriented in a drop of ten-per-cent. gum arabic placed on the small brass plate (*a*) in the center of the table, and a spray of ether is atomized against the corrugated under surface of this plate, producing the necessary low temperature. The atomizer is usually worked by hand with a double bulb, but I have found a compressed-air tank (such as physicians use) a very great convenience, as such a tank allows of the unhindered use of both hands in the microtome work. It also admits of more rapid freezing. I have been able with this apparatus to freeze material in eight seconds on a warm summer's days in Washington, D. C. A foot pump may also be used in place of the double bulb. The knife (*f*) is carried by a shoe (*b*) and is held in place by adjustable screws. The shoe is supported by three bone-tipped adjustable screws, the forward one of which (*c*) is used to set the knife after each stroke in preparation for the next one. The screws rest on a plate-glass top, which covers the table around the central brass plate. The smoothness of motion is facilitated by oil placed on the plate. The atomizer is of the ordinary type. The intake is shown at (*d*), and the ether bottle at (*e*). The ether should be of good quality (that used in medicine for anesthesia) in order to obtain the best results.

The gum arabic may be kept in stoppered bottles, and can be preserved from mold and bacterial attacks by adding a few crystals of carbolic acid or thymol. The sections after cutting can be handled in the ordinary way with section lifters or with small sieve nets of cloth or other substance. The latter method is very useful if the sections are to be transferred to stains and afterwards washed. Very delicate sections may also be handled by means of a loop of fine platinum or brass wire. The sections are caught up in the water drop and are easily transferred to other dishes or to a slide without the injury which is liable to occur in handling with ordinary section lifters. The sections may be mounted in glycerine or glycerine jelly, and can then be permanently mounted, without having touched alcohol if water stains are used. As Hill and Gardiner point out, the dehydration of sections in alcohol may leave protoplasmic structures in a condition very different from the normal. Of course, the effect of freezing is also one which must be taken into account, though this is seldom, if ever, a serious factor in the morphological and anatomical work for which this method is here recommended. Sections for ordinary anatomical work can be cut from fresh material, or from dry material after soaking in water. The material may also be killed by the ordinary methods, preferably without the use of alcohol, and may then be washed in water in the usual way and preserved indefinitely in a concentrated thymol solution. Such material can be prepared for the knife simply by washing carefully in water.

I wish to acknowledge that my acquaintanceship with the possibilities of the microtome described above was made in the Cambridge (England) botanical laboratory, and I am indebted to Mr. A. W. Hill, of Cambridge University, for many courtesies and favors in my observations and study of this method.

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ASTRONOMICAL NOTES

THE YALE PARALLAXES

Transactions of the Astronomical Observatory of Yale University.—Dr. W. L. Elkin, director of the Yale Observatory, undertook, in 1884, by means of the heliometer, the determination of the parallaxes of the ten stars of the first magnitude in the northern sky. This work was carried out with rare ability and success during the following ten years; but before the completion of this work, it was decided to extend the research by undertaking a survey of all rapidly moving stars not previously attempted, with a view to singling out those which are near enough to show a measurable parallax. This work has been carried on during the last thirteen years, and the results have been recently published as Volume II., Part 1, of the Observatory Transactions, under the title, 'Parallax Investigations on 163 stars mainly of Large Proper-

Motion.' The greater part of the observations were made by Dr. F. L. Chase, assistant astronomer, and a smaller number by Mr. M. F. Smith, assistant, and Dr. W. L. Elkin, the director.

It was thought at first that a small number of observations at each of two successive epochs of maximum parallactic effect would certainly show if the parallax amounted to as much as 0″.20, and give some indication of a value as small as 0″.10. Later the plan was extended to include two more epochs taken in reverse order. The results were made to depend wholly on measures of distance, and in general two comparison stars were selected on opposite sides of the star whose parallax was sought.

Systematic personal error, due to the direction of the stars, or to differences in color or brightness, was avoided by the use of a reversing prism eye-piece. Also, gauze screens were used to equalize the brightness of the stars to within half a magnitude. For each star in most cases twelve complete observations were made. Every precaution to eliminate known sources of error was employed, so that the authors have good reason to believe the results to be free from systematic error, except, perhaps, one due to color. Such an error seems to be theoretically possible. In order to ascertain whether an error due to this cause is appreciable in actual observations, Dr. Chase made a series of observations on five highly colored stars. The results appear to indicate, that there is a discernible color effect, which is in accordance with theory; but the errors involved are so small that even in extreme cases, they come within the probable errors, never amounting to more than 0″.03.

All the observations were given equal weight. The effect of poor definition seems to have been inappreciable.

A reliable estimate of the systematic errors of the stars in general is obtainable by a comparison of the Yale parallaxes with those deduced by other able observers. A table of twelve such stars is given from which the average difference between the Yale values and the others amounts to 0″.036, from which, assuming equal accuracy for both results, the total probable error of each is ± 0″.017.

The authors do not claim great precision for the individual results, but attach importance to the mean values of various groups which they formed. With the addition of the ten stars of the first magnitude previously determined by Elkin, the number of stars considered is 173, from which five groups were formed. In each group the stars are arranged as indicated in the following mean results.

TABLE I

Results arranged according to Proper Motion

P. M.	Par.	No. Stars.	Mean Magn.
0″.14	+0″.019	21	3.8
0.49	+0.032	39	6.3
0.59	+0.059	45	6.7
0.77	+0.039	46	6.5
1.50	+0.109	22	6.2

TABLE II

Results arranged according to Stellar Magnitude

Mean Magn.	Par.	No. Stars.	P. M.
0.8	+0″.095	10	0″.61
3.8	+0.066	29	0.53
5.6	+0.056	33	0.63
6.7	+0.045	34	0.73
7.6	+0.017	31	0.68
8.3	+0.047	36	0.80

TABLE III

Results arranged according to Size of Parallax

Par.	No. Stars.	P. M.	Magn.
—0″.110	7	0″.55	7.3
—0.025	29	0.52	6.4
+0.031	66	0.62	6.8
+0.097	44	0.79	6.1
+0.159	17	0.97	6.3

TABLE IV

Results arranged in order of Right Ascension

R. A.	Par.	No. Stars.	Magn.
h h			
0– 3	+0″.074	2.2	7.1
3– 6	+0.056	2.0	5.5
6– 9	+0.047	1.8	6.2
9–12	+0.021	2.2	6.2
12–15	+0.046	1.7	6.4
15–18	+0.078	2.3	6.4
18–21	+0.039	3.0	5.4
21–24	+0.030	2.1	6.3

TABLE V

Results arranged according to Stellar Spectra

Class.		Par.	No. Stars.	Magn.	P. M.
Type I.	A	+0″.065	13	4.0	0″.42
Type II.	E	+0.068	12	6.4	0.71
	G	+0.125	4	4.0	0.69
	I	+0.030	5	5.5	0.67
	F	+0.079	30	4.7	0.66
	L	+0.040	1	4.1	0.11
	H	+0.023	24	6.5	0.65
	K	+0.054	5	1.9	0.88
Type III.	M	+0.007	3	2.1	0.22
	Q	+0.040	2	2.9	0.02

Table I. shows that there is, as might be expected, a distinct relation between parallax and proper motion. Not only are there striking individual exceptions to this law, however, but the group having a mean proper motion of 0″.77, with a mean parallax of + 0″.039, destroys the continuity of the series.

In Table II. may be traced some relation between magnitude and parallax. This comparison would have great interest, had the selection of the stars been differently made. As it is, only the first group of ten stars were chosen with reference to their brightness, while all the rest were selected because of large proper motion, that is, in a general way, because of their nearness. Only a hint can therefore be obtained as to the real relation between the magnitudes and parallaxes of the stars as a whole. The table shows that in general bright stars are nearer than faint ones, though even this obvious truth is apparently refuted by the last two groups, which make stars of mean magnitude 8.3 much nearer than those of magnitude 7.6. It must not be inferred that the actual selection was unwise. Any other selection than that employed would probably have led for the most part to negative results. The authors made the best of an extremely difficult problem, perhaps the most difficult in the whole realm of observational astronomy.

Of Table III. the authors say: "This table may also serve to indicate the number of spurious parallaxes belonging to the work. If, according to Newcomb, we regard all the negative results as due to errors of observation, and likewise an equal number of positive values to balance these, it would seem that all seventeen of the group with parallaxes between + 0″.14 and + 0″.20 are real, 38 of those from + 0″.07 to + 0″.13 and 35 of those under +0″.06. Thus there are 90 stars of the entire list of 163, for which there is considerable presumption that the parallax values found are actual."

Tables IV. and V. appear to lead to results of small importance so far as distribution is concerned.

Finally, a summary is given for the different groups, except for Table III., of the average total stellar velocity relative to the sun, and of the luminosity relative to the sun. In this summary the greater luminosity of the brighter stars is strikingly shown.

Too high praise can hardly be given to these parallax investigations, carried on during so many years. Yet the results, though of great value in themselves, do not encourage the hope that by similar heliometer observations we shall ever gain a knowledge of the distances of any large number of stars, especially of those most distant. It is doubtful if we have, at the present time, any mode of research sufficiently refined to determine the parallaxes of the most distant members of our sidereal system. The quantities involved are too small. By more powerful instruments, especially by photographic telescopes of great focal length, it may be possible to determine smaller values than those yet found. The relation between proper motion and parallax offers a hopeful means for the determination of mean values, but this method has limitations. The relation between magnitude and distance is as yet uncertain. Indeed, the solution of the most difficult parts of the problem calls for some new means of research far more powerful than any known at the present time.

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PLATTSBURG MEETING OF THE SECTION OF GEOLOGY AND GEOGRAPHY

SECTION E will hold a summer field meeting, July 3–10, 1907, in New York State in the